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⑩ **Biological sludge hygienisation process.**

⑩ A process for the stabilised hygienisation of biological sludge is disclosed which is characterised by a salting treatment of the biological sludge through the addition of at least one salt of a cation selected from those of alkaline and alkaline-earth metals and ammonium. Salts of inorganic acids such as sulphates, phosphates, nitrates, chlorides, or organic acids such as acetates, especially ammonium acetates, even reclaimed ones, are added preferably in amounts ranging from 3% to 90% by weight, in the form of crystalline salts or saturated aqueous solutions. Hygienised and stabilised sludges are obtained which are suitable for pumping and may be disposed of in conformity with strict enforced regulations. By an appropriate selection and dosage of the salts, the resulting hygienised slurries may be beneficiated with fertilising N, P, K, Ca elements which make them suitable for use in agriculture and economically valuable. The hygienisation effect is retained even after drying, thus avoiding the risk of re-contamination.

**EP 0 143 392 A1**

**"BIOLOGICAL SLUDGE HYGIENISATION PROCESS"**

This invention relates to a process for the hygienisation of biological sludge.

In particular, the present invention is concerned with a process for hygienising biological conditioned 5 sludges issuing from the treatment of sewage to make it suitable for disposal at controlled dumps, in conformity with existing regulations.

According to an interesting aspect of the invention, the process yields hygienised slurries or suspensions 10 which may be used in agriculture as fertilizers, by beneficiating their content in fertilising elements.

Thus, the invention falls within the frame of recently developed technologies related to the environmental problems involved by the need to dispose 15 of large amounts of organic sludge or sewage of either human or animal origin and having a high, actual or potential, content of biological polluting matter, mainly of fecal derivation.

Conversion of such sludge or sewage of substantially 20 organic and fecal nature, whether of human or animal origin, into hygienised materials having the consistency of pumpable slurries or suspensions, according to the invention, represents a useful alternative to the hygienisation and/or disposal methods hitherto adopted 25 and presently no longer compatible with the strict regulations currently enforced on environmental protection.

Depuration of such organic sludge involves, as products issuing from removal of the contaminating 30 phase, obtainment of a slurry having a varying

concentration dry content, essentially in a suspension state. Said content comprises, in addition to contaminating matter of chemical nature, a large amount of all the forms of enteric microorganisms of

5      fecal derivation or "bacterial charge", especially of the saprophytic type, as well as minor amounts of pathogenic or potentially pathogenic organisms which, for example, in some particular local conditions of concentrated population and activities (such as

10     hospitals, etc.), may attain very high totals and pose special problems.

The problem of how to make depuration sludges hygienically harmless has been the object of several proposals and approaches, described in the literature.

15     Known are destructive (incinerating) methods of sludge treatment, which besides being unrelated to the method of this invention, have the disadvantage of a high cost in term of energy requirements which is not always acceptable.

20     Direct disposal over the ground, either in the liquid or dehydrated states, of the sludges at urban dumps involves proper operation of the latter to avoid endangering the water bed, with attendant problems of finding suitable areas, etc. On the other hand, there

25     are areas where disposal is provided over agricultural soil, with the risk of contact with animals, humans (salmonellosis) and vegetables for human consumption, in spite of its being carried out by spreading such dehydrated sludges over the ground prior to the

30     vegetative phase of cultivations and not on growing

plants. However, there exist highly restrictive regulatory bodies on this disposal method.

Such methods are highly objectionable in the light of statistical conclusions on the increased incidence 5 of salmonellosis attributable to the utilisation of biological sludges in agriculture.

On the other hand, it is scientifically ascertained that the infective danger of the pathogenic micro-organisms, which only make up a small portion of the 10 microbial flora present therein, is more than proportional to their number; in other words, it is known that for the appearance of the disease a "minimum infecting dose" is required, thereby a few scattered organisms would make the pathological 15 situation unlikely to occur. And the more so because, once removed from their intestinal environment, pathogenic bacteria and viruses especially are substantially unable to reproduce themselves outside 20 of the host organism. The differing environmental conditions (pH, temperature, solar radiation, humidity, predation, etc.) contribute to their becoming rarefied and disappearing over a more or less long time period.

It would, therefore, be acceptable from a practical standpoint that a process should lead, if 25 not to complete elimination, to a drastic reduction of the microorganism content in conditions of substantial static multiplicative equilibrium (stabilisation), like the one forming the subject matter of this invention.

30 The objective of reducing and, if possible,

eliminating all forms of pathogenic microorganisms has underlaid several processes of treatment proper of depuration sludges. Such processes are based on the following arrangements.

- 5       Anaerobic mesophilic digestion at 33°C: this showed to be inadequately effective, as did cold aerobic digestion, especially to fill the current strict regulatory body requisites.
- 10      Autothermal thermophilic aerobic digestion: this employs the exothermy of the biological reaction to raise temperature up to 80°C, through the use of pure oxygen, and appears to provide satisfactory results, but at the expense of high operating and investment costs.
- 15      Pasteurisation: the process takes place at about 70°C over a suitable time period, and in general, the sludge is digested, prior to or especially after pasteurisation; however, there still exist problems of re-contamination. This treatment is then followed,
- 20      with some processes, by an additional treatment consisting of additivating quicklime into the pasteuriser; this additivation, however, has yielded no results of interest per se.
- 25      Thermal drying: at 100°C down to a 15% water content; is prohibitive in terms of energy costs.
- 30      Accordingly, there exists in the current state of the art a serious deficiency as regards the factual possibility of solving, in an effective manner not liable to reappearance, the problem of hygienising biological sludges of significant environmental

involvement, while affording consistent results with modern requirements.

It is, therefore, an object of this invention to provide a process for the stabilised hygienisation of 5 biological sludge from sewage depuration processes or other sources, whether of human or animal nature, in general of slurry-like suspensions having a high biological polluting content of fecal origin, which process is free of the drawbacks exhibited by the 10 cited prior processes.

A further object of this invention is to provide an improved process for the stabilised hygienisation of such biological sludges, which is simple and economical, has decreased energy consumption, and 15 reduced operational or plant set up requirements.

It is another object of the invention to arrange, as mentioned, in a preferred, effective and economical embodiment thereof, for this process to yield liquors which can be used as fertilisers having a beneficiated 20 content of fertilising elements.

These and other objects, such as will be apparent to the skilled one from the description which follows, are achieved, according to this invention, by a process for the stabilised hygienisation of biological sludge, 25 as indicated, characterised in that said sludge is subjected to a salting treatment comprising the addition of at least one salt of a cation selected from those of alkaline and alkaline-earth metals and ammonium.

30 In other terms, it has been unexpectedly found

that the addition of, or "salting" with, at least one salt of a cation of an alkaline and/or alkaline-earth metal or ammonium, e.g. until a pumpable liquid consistency is attained, with possible topping with 5 a required amount of  $H_2O$ , yields a drastic and lasting decrease in the microbiological content or "bacterial charge" of the sludge, making it de facto hygienised and suitable for dumping and optionally, depending on the salts used, reclaimable for agricultural 10 applications. The hygienising effect is retained stably even after the sludge has been fully or partly dried.

By way of example, "Downing Indices" are obtained which empirically refer to the ratio of the bacterial content, such as fecal streptococci, of the sludge as 15 such to that of the final hygienised slurry, on the order of 2300, or as similarly computed for fecal coliforms, on the order of 1100, with negative salmonellae on analysis.

Usable as mentioned in the "salting" treatment 20 are salts of cations of alkaline or alkaline-earth metals or ammonium, either alone or mixed together. Ammonium salts are preferred. The anionic portion bears no critical influence on the process effectiveness; compatible are anions of inorganic or organic acids, 25 such as hydrochloric, sulphuric, phosphoric, nitric acid etc. among the inorganic, and acetic acid, etc. among the organic.

The use of the following salts has shown to be effective: ammonium sulphate, phosphates, chloride and 30 nitrate; potassium, sodium, magnesium, calcium

sulphates, chlorides and phosphates; sodium and potassium nitrates; and their respective acetates or mixtures thereof. Ammonium sulphate and monobasic phosphate are preferred.

5       Through an appropriate selection of the salts, as balanced according to the desired final fertilising product, a product may be obtained, as solid or liquid final hygienised slurry, which is beneficiated with N,P,K,Ca-based fertilising elements ready for use in  
10      agricultural applications.

The salts may be used in their solid crystalline state, possibly as associated with water, or preferably, in a generally concentrated or substantially saturated solution. Also usable are non-pure salts or salt  
15      mixtures, reclaimed as process byproducts. As an example, it would be possible to use the ammonium sulphate byproduct of the caprolactam process, etc. From this point of view, this invention affords the faculty of implementing it by a process employing  
20      essentially waste materials, to result in self-reclaim of the final hygienised slurry; thus, positive aspects of economical recovery are achieved in a technological field which normally represents an economical burden for communities.

25       The amount of salt or salt mixture added may vary over a wide range, which would be practically defined by the desired degree of hygienisation or "Downing Index" according to the ~~microbi~~ biological content or "bacterial charge" determined for the sludge to be  
30      treated.

Thus, viable may be, within the scope of the invention, "saltings" or additions of salt or salt mixtures ranging in actual practice from 3% to 90% by weight with respect to the sludge as such to be

5 hygienised.

Of course, depending on the composition (liquid/solid) of the sludge to be treated, on its biological content to be downed, and type and amount of the "salting" envisaged, it may prove necessary, e.g. in

10 the instance of solid salts being used, to restore the consistency of the treated slurry back to pumpability through the addition of water.

Usable in practice is water in amounts yielding a dry solid content in the pumpable slurry ranging

15 from about 0.1% to 20% by weight.

Thus, there exist wide quantitative and qualitative limits to the scope of this invention, within which the type of salt or salt mixture to be used and related amounts and ratios may be selected to

20 suit the nature of the sludge to be treated and provide the results sought.

The process is carried out in the presence of a pH value approximately included between 2 and 10, which value, when not to be found in the starting

25 sludge, can be adjusted within the above range in an easy manner by the additivation of acidic or basic, usually mineral, conditioners such as HCl,  $H_2SO_4$ , or NaOH,  $Ca(OH)_2$ , etc. The process is preferably conducted with an acidic to slightly acidic pH in the

30 approximate range of 2 to 6.

Finally, the operating temperature ranges as a rule from ambient to about 90°C, depending on the nature of the sludge, the operative times or accelerated maturing time, etc., a preferred temperature range being 5 40°C to about 80°C for best and/or faster results.

Likewise, the salting process of this invention is more or less protracted in time according to the various parameters involved, such as the nature of the sludge, quality and quantity of the "salting" or of 10 the salt(s), temperature, etc. Time periods in the approximate range of 3 to 12 hours are usually workable.

Within the above parameter ranges, results of special interest are yielded by using at least 10% of salt or salt mixture, as calculated by weight with 15 respect to the weight of the sludge as such to be treated, preferably at least approximately 15% by weight, depending on the salt type or type of salting mixture.

Specially advantageous results are to be obtained with the use of saturated aqueous solutions of 20 ammonium sulphate and/or monobasic phosphate in amounts ranging from 40% to 50% by weight with respect to the sludge as such, and at a pH in the approximate range of 2 to 6.

From the standpoint of workability, the process 25 of this invention can be carried out with simple conventional procedures and equipment.

In essence, it is a matter of adding, while stirring, the salt(s) for the selected "salting" to the sludge as such, in preset amounts and ratios, in 30 a waterproofed tank which may be heated in a

conventional fashion, until the mass becomes fully homogenised, over a required time period, under micro-biological control. The resulting hygienised mass is then passed to storage for dumping or its use.

5 The process of this invention is specially advantageous on account of the simple and inexpensive materials and equipment that it requires and of its mild process conditions.

Specifically, it enables high "Downing Indices" 10 to be achieved in the hygienised slurries, which meet the requirements of strict regulatory bodies. Such hygienisation also fills requisites of stability over time with an attenuated or no risk of re-contamination.

Furthermore, through an appropriate selection and 15 dosage of salts in a calibrated salting mixture, it becomes possible to produce a pumpable slurry which may be dehydrated and is hygienised and beneficiated with fertilising elements, thereby it may be readily utilised in agriculture to advantageously reevaluate 20 biological sludge from the economical standpoint.

Finally, and as pointed out in the foregoing, 25 impurity-containing salts or salt solutions may be used such as frequently form reclaim and/or waste materials from a variety of industrial processes, thereby their use imparts the process of this invention with an aspect of self-reclaim and/or economical revaluation of waste materials which is quite attractive.

The invention will be now described more specifically 30 in the examples given herein below for

illustrative purposes.

Examples 1 to 20

The tests have been carried out in the Examples in the same operating conditions throughout, by merely 5 changing parameters within the indicated ranges.

The operating conditions were as follows:

1 kg biological sludge as such, with 10% solid residue, has been additivated with predetermined amounts of salt for the salting in the form of a saturated 10 aqueous solution. The mixture has been maintained under agitation mechanically in a waterproofed tray equipped with electric heaters, at the temperature and pH sought.

Homogenisation lasted for about 6 hours.

Then, the bacterial charge of the hygienised slurry 15 yielded has been ascertained and compared to that found in a sample of the untreated biological sludge as such.

The parameters and results are as shown in Tables 1 to 5 herein below. The characters A, B, C, D, E denote the origins of the sludge to be treated, namely:

20 A = from urban depurator or conditioner;

B = from depuration of dyeing plant waste;

C = from depuration of pharmaceutical plant waste;

D = from depuration of food processing (dairy) plant waste;

25 E = mixture of sludges of the A and B types.

Under the entries "Fecal streptococci" and "Colimetry", the figures under "I" denote the respective "Downing Indices", "I" being short for "Downing Index".

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In Table 1

Bacterial charge of biological sludge A, as such:

Fecal streptococci	70,000/g
Colimetry	4,600/g
5      Salmonellae	positive

In Table 2

Bacterial charge of biological sludge B, as such:

Fecal streptococci	100,000/g
Colimetry	230,000/g
10     Salmonellae	negative

In Table 3

Bacterial charge of biological sludge C, as such:

Fecal streptococci	180,000,000/g
Colimetry	230,000/g
15     Salmonellae	negative

In Table 4

Bacterial charge of biological sludge D, as such:

Fecal streptococci	10,000/g
Colimetry	4,600/g
20     Salmonellae	negative

In Table 5

Bacterial charge of biological sludge E, as such:

Fecal streptococci	70,000,000/g
Colimetry	22,000/g
25     Salmonellae	positive

TABLE 1

Example	°C	pH	Salting	% Sat. Sol.		F. streptococci per g	Colimetry per g	I	Salmo- nella
				sludge a.s.	by weight				
1	ambi- ent	6	Ammonium sulphate	50	< 30	>2333	4	1150	Nega- tive
2	80	2.5-3	do.	50	< 30	>2333	5	920	do.
3	80	2.5-3	do.	40	130	538	5	920	do.
4	80	2.5-3	do.	30	20,000	3.5	120	38	do.

TABLE 2

Example	°C	pH	Salting	% Sat. Sol.		F. streptococci per g	Colimetry per g	I	Salmo- nella
				sludge a.s.	by weight				
5	ambi- ent	6	Ammonium sulphate	50	32,000	3	4600	50	Nega- tive
6	80	2.5-3	do.	50	15,000	7	1800	128	do.
7	80	2.5-3	do.	40	22,000	4.5	2000	115	do.
8	80	2.5-3	do.	30	25,000	4	2200	104	do.

TABLE 3

Example	°C	pH	Salting	% Sat. Sol.		F. streptococci per g	Colimetry per g	I	Salmo- nella
				sludge a.s. by weight	I				
9	ambi- ent	6	Ammonium sulphate	50		720,000	250	4600	50
10	80	2.5-3	do.	50		250,000	720	1000	230
11	80	2.5-3	do.	40		420,000	429	2500	92
12	80	2.5-3	do.	30		450,000	400	2700	85.

TABLE 4

Example	°C	pH	Salting	% Sat. Sol.		F. streptococci per g	Colimetry per g	I	Salmo- nella
				sludge a.s. by weight	I				
13	ambi- ent	6	Ammonium sulphate	50	< 30	>333	15	306	Nega- tive
14	80	2.5-3	do.	50	< 30	>333	10	460	do.
15	"	2.5-3	do.	40	< 30	>333	20	230	do.
16	"	2.5-3	do.	30	150	67	55	84	do.

TABLE 5

Example	°C	pH	Salting	% Sat. Sol.		F. streptococci		Colimetry		Salmo-nellae
				Sludge a.s.	by weight	per g	1	per g	1	
17	ambient	Not de.	Ammonium sulphate	50		830,000	84	210	105	Negative
18	do.	Not de.	Monobasic ammonium phosphate	30		40,000	1750	2000	11	do.
19	do.	Not de.	do.	50		50,000	1400	420	52	do.
20	do.	Not de.	Potassium chloride	50		1,550,000	45	110	200	do.

CLAIMS

1        1. A process for the stabilised hygienisation of  
2        biological sludge, characterised in that the biological  
3        sludge is subjected to a salting treatment comprising  
4        the addition of at least one salt of a cation  
5        selected from those of alkaline and alkaline-earth  
6        metals and ammonium.

1        2. A process according to Claim 1, characterised  
2        in that for said salting step at least one salt is  
3        used as selected from the sulphates, phosphates,  
4        chlorides, nitrates of ammonium, sodium, potassium,  
5        calcium, magnesium and respective acetates.

1        3. A process according to Claim 1, characterised  
2        in that for said salting step at least one salt is  
3        used as selected from ammonium sulphate, phosphates,  
4        chloride, nitrate and acetate.

1        4. A process according to Claim 1, characterised  
2        in that for said salting step at least one salt is  
3        used as selected from ammonium sulphate and monobasic  
4        ammonium phosphate.

1        5. A process according to Claim 1, characterised  
2        in that an overall amount of salt or salt mixture is  
3        used in the approximate range of 3% to 90% by weight  
4        with respect to the sludge as such to be hygienised.

1        6. A process according to Claim 1, characterised  
2        in that the process is conducted at a pH value in the  
3        approximate range of 2 to 10, preferably in the  
4        approximate range of 2 to 6, with the optional  
5        additivation of basicity/ acidity conditioning agents.

1        7. A process according to Claim 1, characterised

2 in that the process is conducted at a temperature  
3 ranging from ambient to about 90°C, preferably from  
4 40°C to about 80°C.

1 8. A process according to Claim 5, characterised  
2 in that an overall amount of salt or salt mixture  
3 is used equal to at least 10%, preferably 15%, by weight  
4 with respect to the sludge as such to be treated.

1 9. A process according to Claim 1, characterised  
2 in that said salting step of the biological sludge is  
3 carried out with a balanced mixture of N,K,P,Ca  
4 fertilising element carrier salts in the final  
5 hygienised slurry.

1 10. A process according to Claim 1, characterised  
2 in that the salt or salt mixture is used in the solid  
3 crystalline state thereof.

1 11. A process according to Claim 1, characterised  
2 in that the salt or salt mixture is used in the form  
3 of a substantially saturated solution.

1 12. A process according to Claim 1, characterised  
2 in that for said salting step one or more impure salts  
3 are used being process byproducts or waste products.

1 13. A process according to Claim 1, characterised  
2 in that said salting step is carried out by the  
3 addition of a saturated aqueous solution in amounts  
4 ranging approximately from 40% to 50% by weight with  
5 respect to the sludge as such of a salt selected from  
6 ammonium sulphate and ammonium monobasic phosphate at  
7 a pH in the approximate range of 2 to 3.

1 14. A process according to the preceding claims,  
2 characterised in that the salting treatment is carried

3 out over a time period varying approximately from 3  
4 to 12 hours.

1 15. A process for the hygienisation of biological  
2 sludge, as herein described and exemplified.



EUROPEAN SEARCH REPORT

0143392  
Application number

EP 84 11 3712

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
X	US-A-4 038 181 (AGWAY, INC.) * Column 4, claims 1-4; column 2, line 63 - column 3, line 4 *	1-7, 10, 11, 13, 14	C 02 F 11/14 C 02 F 11/18
A	DE-A-1 806 732 (ALBERT KLEIN KG.) * Page 5, claims 1,2; page 3, line 2 - page 3, paragraph 1 *	1, 5, 7, 9, 10	
A	DE-A-1 484 826 (DÜNGEMITTEL-TECHNIK AG.) * Page 5, claims 1,3 *	1, 7, 9, 10, 12	
A	DE-B-2 146 388 (PB GELATINES) * Column 1, claim 1 *	1, 2, 7, 10	C 02 F
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int. Cl.4)
Place of search	Date of completion of the search	Examiner	
THE HAGUE	19-02-1985	TEPLY	
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	
X : particularly relevant if taken alone			
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